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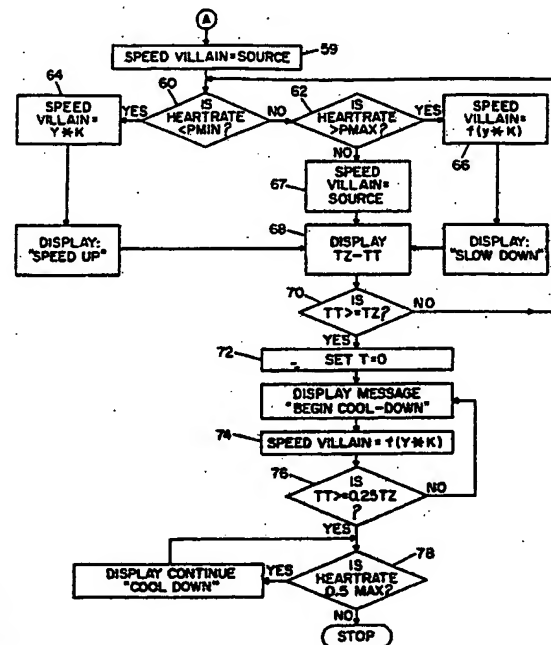
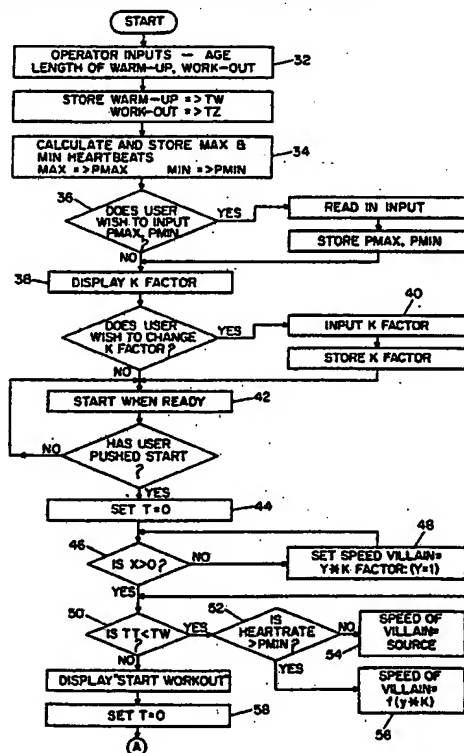
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## (54) Title: EXERCISE AND VIDEO GAME DEVICE



## (57) Abstract

An exercise device, such as an exercise bicycle, is connected to a speed sensor indicating activity level, e.g. speed of the bicycle. The activity level signal, along with a heart rate signal, are provided to a video game, such as a Pac-man type video game. The game monitors the heart rate of the exerciser. If the heart rate falls outside preset minimum or maximum limits (steps 60, 62),

a certain action occurs in the game, such as an increase in speed or skill level of the opposition (steps 64, 66). In the Pac-man type game for example, should the heart rate fall below the desired workout rate, the villain (the goblin) would move at a speed faster than the players' speed, putting the player at a disadvantage. The player would respond by increasing his level of physical activity, thereby increasing the heart rate until it exceeds the minimum aerobic level required, at which time the villain's speed would return to its normal level.

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EXERCISE AND VIDEO GAME DEVICEBACKGROUND OF THE INVENTION

5 The present invention is directed to an exercise and video game device, and more particularly to an aerobic exercise and video game device to encourage people to commence and continue an aerobic exercise program.

10 It is generally accepted today that aerobic exercise promotes cardiovascular fitness. Exercise increases the continuous flow of blood through the heart and large skeletal muscles, increasing their effectiveness. More importantly, exercise helps fight, or prevent,  
15 atherosclerosis (narrowing of arteries) and coronary heart disease.

It has been estimated that 50% of all people who start an exercise program fail to keep exercising beyond three  
20 months. Though there can be many reasons for this drop out rate, a primary reason is probably the tedious nature of exercise programs.

The introduction and rapid acceptance of video games over  
25 the last ten years have, to a great extent, altered the traditional game market, certainly with regard to the younger generations. The inherently addictive nature of video games (i.e., one has to play repeatedly to gain sufficient skills to progress through all the levels of

play) has probably caused those that play them to shun the traditional board games.

The present invention integrates the operation of a video game with an exercise program, in the hope that those who use this invention will find that the addictive nature of the video game will keep them involved longer in an exercise program.

10 Video games are usually constructed with multiple levels, each level being progressively harder to complete than the previous one. For progress to occur through all the levels of the game, the game player must learn his way through the game. This often requires repeated tries at each level, 15 with a scoring system recording the progress achieved. Effective fitness routines share many of the characteristics of video games. Not only is fitness achieved through repeated exercise, but once the exerciser gets used to a particular level of exercise, further 20 increases in the level of fitness are achieved only if the workout level becomes progressively harder and the workout time at the harder level is increased. This process continues until the exerciser reaches the desired standard of fitness.

25

For example, it would be very unlikely, and also imprudent, for an individual who is not fit to attempt a marathon on

the first day of a fitness program. Similarly, it is nearly impossible for an inexperienced video player to attempt the ultimate level of expertise at his first attempt at the game. Both the exercise program and the  
5 video game play must be progressed through layered levels of increasing difficulty, each one taking perhaps a longer period of time, so that each level is perfected before the next level is attempted.

10 Combining exercising programs and video game playing, with the heart rate of the game player controlling the speed of the video game, would not only make exercising less tedious, but would ensure that the exerciser does not over-exert himself.

15

Various patents have attempted to integrate video games with exercise equipment; the primary focus of these patents being to ensure that the routine of exercise is made less onerous.

20

U.S. Patent No. 4,720,789 to Hector discloses a video game, or an exercise system utilizing a video display, which is played by movement of the game player's feet. The apparent objective is to require the game player to exercise while  
25 playing the game by moving his feet. However, the game player is required to move at the game's speed. The game

in no way alters to conform to the individual's fitness level.

U.S. Patent No. 4,711,447 to Mansfield integrates an  
5 exercise machine with a video game. To play the game, the operator is required to move a resistance creating assembly, and in doing so, exercises. As with the previous patent, no attempt is made to adjust the video game to the player's fitness level.

10

U.S. Patent No. 4,278,095 to Lapeyre discloses an exercise device connected to a video machine. The speed of the exercise device, and the accompanying video display, is controlled by the exerciser. As the exerciser signals an  
15 increase in speed to the exercise device, an accompanying signal is sent to the video machine, so that the exerciser is presented with a visual display of the increase in speed. The exerciser's heart rate is monitored and displayed a T.V. monitor.

20

U.S. Patent No. 4,512,567 to Phillips is directed to an exercise bicycle used to operate a video game. The game player receives exercise while operating the bicycle, and at the same time, moving the handlebars. The video game  
25 operates at a preset speed, thus making no allowance for the fitness of the player.

U.S. Patent No. 4,630,817 to Buckley is directed to an exercise machine which allows for movement of a control rod, e.g. a handlebar, to provide two degrees of freedom to a controllable character in a video display. Resistance is  
5 provide to the handlebar to ensure that physical exertion is required by the user.

U.S. Patent No. 4,709,917 to Yang discloses an exercise device which is furnished with an electronic display or a  
10 mechanical belt for simulating road conditions. A microprocessor controls the position of the exercise bicycle with respect to the scene being displayed and the running speed of the road condition simulation.

15 The intent of all these patents is to integrate exercise with video display. However, except for the Lapeyre U.S. Patent No. 4,278,095 which displays the heart rate, none of them suggest monitoring the heart rate of the exerciser. Furthermore, none of them appear to disclose any means for  
20 altering the speed or skill level of the opposition in a video display in response to the output level of the exercise device falling outside a preset range.



SUMMARY OF THE INVENTION

In accordance with the present invention, a combination exercise device and game apparatus is provided. The apparatus according to the invention comprises an exercise device for aerobic activity and means for sensing the aerobic activity level of a user of said exercise device and for outputting an activity level signal having a characteristic indicative of said activity level. The apparatus further comprises a video game having at least one user operated control for controlling the actions of at least one player, regulating means for regulating the relative actions of said one player and one of an opposition piece or obstacle, display means for displaying the one player and the one of said opposition piece or obstacle, and wherein said regulating means renders the video game more difficult for the one player relative to the opposition piece or obstacle in response to activity level, as indicated by the activity level signal characteristic, falling below a first predetermined level.

20

The exercise device can be an exercise bicycle, treadmill or stair climbing device, for example. The means for sensing the aerobic activity level can be means for sensing the heart rate of the user of the exercise device, or can be means for sensing the output of the exercise device.

The regulating means may further increase the speed of the opposition piece or obstacle relative to the one player in response to the heart rate of the user falling below the first predetermined level. The first predetermined level  
5 may correspond to the minimum aerobic activity level for the user, which can be selected according to the user's age. The regulating means may preferably render the video game less difficult to the one player in response to the activity level exceeding a second predetermined level,  
10 where the second predetermined level is greater than said first predetermined level. The second predetermined level preferably corresponds to the maximum heart rate of the user in an optimum aerobic exercise range.

15 If the regulating means is responsive to the user's heart rate and the means for sensing also senses the output of the exercise device, the apparatus may be arranged so that the speed of the player and the opposition piece or obstacle both increase or decrease, respectively, in  
20 response to the increase or decrease, respectively, of the output of the exercise device. The display means may display the heart rate of the user, and/or the output level of the exercise device.

25

According to another aspect of the invention, a game apparatus useable with an exercise device is provided

comprising means for sensing the aerobic activity level of a user of an exercise device and for outputting an activity level signal having a characteristic indicative of said activity level, and a video game having at least one user  
5 operated control for controlling the actions of at least one player, display means for displaying the one player and the one of said opposition piece or obstacle, and wherein said regulating means renders the video game more difficult for the one player relative to the opposition piece or  
10 obstacle in response to activity level, as indicated by the activity level signal characteristic, falling below a first predetermined level.

According to another aspect of the invention, an exercise  
15 motivation apparatus is provided which is useable with an exercise device and a video game having at least one user operated control for controlling the actions of at least one player, and which controls the relative actions said one player and of one of an opposition piece or obstacle,  
20 and which displays the one player and the one of said opposition piece or obstacle, comprising means for sensing the aerobic activity level of a user of an exercise device, and for outputting an activity level signal having a characteristic indicative of said activity level and  
25 regulating means for rendering the video game more difficult for the one player relative to the opposition piece or obstacle in response to activity level, as

indicated by the activity level signal characteristic falling below a first predetermined level.

In accordance with one form of the present invention, a  
5 controller, with three inputs, is integrated with a video  
game. The first input is from a speed sensor connected to  
an exercise machine. The speed sensor measures the speed  
with which an exercise machine is being used. The second  
input is from a heart rate monitor that is attached to the  
10 person using the exercise machine. The third input is from  
a joystick that is operated by the exerciser.

In the standard format of a video game, a game player,  
using some form of joystick, maneuvers a player or playing  
15 piece in the form of an object (the source) through the  
game, encountering one or more opposition pieces and/or  
various obstacles sometimes called villains to his progress  
along the way. The obstacles are usually designed to  
destroy the game player's piece. The source and villains'  
20 speed are preset in the game's computer source code. Each  
game continues until all the game player's lives have been  
used up. A point counting system measures the game  
player's progress through the game. As used herein the  
term player refers to the playing piece controlled by the  
25 exerciser, and can be an object or even a weapon as shown  
on the video display. The term opposition or obstacle  
means any playing piece which serves as an obstacle,

opposition or adversary to the player and can be a target if the player is a weapon. Of course, the player can be a target, in which case the opposition may be or may have a weapon.

5

In this invention, the mechanics of the video game are altered to integrate an individual's exercise routine. The speed the source moves in the video game is determined by the speed that the exerciser is using the exercise  
10 equipment. This is measured by the speed sensor. Directional movement of the source may be controlled using a standard joystick. The speed of the villain is determined according to the game player's pulse, recorded with the heart rate monitor.

15

An exerciser, prior to commencing a workout, inputs his age, and the preferred duration of his warm-up and workout. According to a preset formula, the controller sets upper and lower heart rates for the duration of the  
20 exercise routine. These heart rates may be overridden by user input. Once the exerciser commences the exercise routine, the controller continually checks the pulse of the exerciser against the upper and lower optimal exercise heart rates for that individual. If the heart rate falls  
25 outside the preset limits or bands at any time throughout the exercise routine the speed of the game is altered.

Where the video game is Pac-man, for example, if the heart rate of the exercising individual falls below the preset minimum optimal heart rate, the villain, in this game the Goblin, would move faster than its normal speed. This  
5 should prompt the game player to speed up on the exercise machine, thereby increasing the speed of the source, called the Pac-man, to escape the Goblin.

The primary object of the invention is to keep people  
10 motivated to exercise, and particularly to exercise within an optimal range of heartbeats per minute. Since the exerciser will become fitter over time, the speed of the exercise machine needed to keep the heart rate within the optimal aerobic range would increase. The video game  
15 continually motivates the game player to maintain aerobic efficiency.

The video game may include a display such as a bar graph, indicating the present heart rate, and its relation to the  
20 minimum and maximum limits.

Further objects and advantages will become apparent in conjunction with the following detailed description, claims and accompanying drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is a block diagram of an exercise and video game device according to the invention with controller and input  
5 devices,

Fig. 2 illustrates the optimal heart rate during aerobic exercise,

10 Fig. 3 is an example of an optimal exercise routine for a 30 year old individual, and

Fig. 4 is a flowchart of the logic of a video game arranged according to the invention that accepts input from the  
15 speed sensor and heart monitor.

**DESCRIPTION OF THE PREFERRED EMBODIMENT**

Figure 1 is a block diagram of a video game includes a video display 10, a microprocessor 12, random access data memory 14, a video controller 16, read only memory 18 for storing programs, and a hand operated joystick and other controls or inputs 20. The hand operated joystick 20 may also be in the form of an x-direction control which is mounted on the exercise machine 28 for operation by one of the user's hands, and a y-direction control mounted for the other user's hands. Also shown are a speed sensor 24, connected to an exercise machine 28, (for example an exercise bicycle, treadmill or stair climbing exerciser), and a heart rate monitor 26, which is used to measure the pulse of the exerciser 30, i.e. the user of the exercise machine. The speed of the exercise bicycle and the pulse rate are passed via the input interface 22 to the game microprocessor 12.

Before discussing the operation of the preferred embodiment and program operation according to the flowchart in Fig. 4, a discussion of a typical fitness program will be given first.

Physicians recommend that aerobic exercise should be maintained for a period of twenty minutes at least three times per week. The optimal level of activity is for



exercise to increase the pulse rate to between 70% and 80-85% of maximum attainable heart rate (approximately found using the formula of 220 minus the user's age in years).

(Fig. 2) Fitness authorities recommend that fitness programs consist of three parts: warm-up, work-out and cool-down. (See Fig. 3):

10 (a) Warm-up period - between 5 and 10 minutes. The heart beat should not exceed 50% of the user's maximal heart rate at the conclusion of the warm-up period.

15 (b) Work-out - Period of vigorous exercise within the recommended aerobic range as determined by the user's heart or pulse rate.

20 (c) Cool-down - easing up on the exercise intensity over a 5 to 10 minute period before stopping. The pulse at the end of the cool down period should be back to less than 50 percent of maximal attainable heart rate.

25 It is important that while alleviating the boredom of exercise with interactive video games, one does not encourage the exerciser to over-exert his heart. In

accordance with the present invention, means are provided, as will be described, to encourage an exerciser to stay above the minimum recommended aerobic level, but at the same time not exceed the maximum aerobic level.

5

Figure 4 describes the flow-chart for the logic of the video game in accordance with a program stored in read only memory 18. Prior to starting a work-out, the exerciser inputs his age, length of warm-up (Tw) and length of main  
10 work-out (Tz) at step 30. According to the recommended level of exercise described in Figures 2 and 3 and discussed earlier, the optimal range of heart rate required during exercise for a person of the entered age is calculated and displayed in step 34. Should the exerciser  
15 wish to override the recommended heart rate, perhaps on the advice of his doctor, a different upper (Pmax) and lower (Pmin) heart rate may be manually entered at step 36.

The purpose of recording the heart rate is to ensure that  
20 the exerciser exercises optimally, but does not over exert his or her heart. Should the heart rate of the exerciser fall outside the optimal heart rate range calculated, or the manually entered range, the speed of the opposition or villain changes in relation to the speed of the source.  
25 The variable that controls the villain's relative speed, and thus represents the advantage or disadvantage the villain will have in relation to the source, is a settable

constant called the K factor. The video game will have a default K factor value, between 1.1 and 1.5 for example, and it is displayed after the exerciser has inputted his workout information at step 38. Should the exerciser wish  
5 to change the default K factor, a new K factor may be manually entered at step 40.

With the required information entered, the exercise routine can commence once the operator presses the start button at  
10 step 42, whereupon the internal timer (T) begins at step 44, and the time remaining in the warm-up is displayed on the screen.

Since the speed the source or one player moves in the video  
15 game is proportional to the speed that the exerciser uses the exercise machine, if the exerciser fails to begin the workout, the source or one player will remain stationary on the screen at step 46. The villain immediately gets an advantage versus the source, which at this point is  
20 stationary, in that its speed is the game's preset speed (set at 1) multiplied by the K factor effect at step 48. For example, if the K factor has been set to 1.5, the villain's speed will be one and a half times faster than its preset value. The villain will gain rapidly on the  
25 source, prompting the exerciser to begin his warm-up, and get away from the villain.

While the warm-up continues in step 50, the heart rate of the exerciser is continually checked to ensure that it does not deviate from the optimal work-out rate at step 52. As long as the exerciser's heart rate remains below the  
5 minimum aerobic rate  $P_{min}$  the villain's speed is directly proportional to the source's speed  $Y$  (see step 54). However should the heart rate exceed the minimum aerobic rate, thus indicating that the exerciser is working-out too vigorously during the warm-up, the villain's speed is  
10 reduced below that of the source (See step 56) by a factor which is the product of  $f$  and  $K$ . For example if  $K=1.5$  and  $f=0.6$ , then the villain's speed is 0.9 times that of the source. This will prompt the exerciser to slow down.

15 Once the warm-up period ceases as detected in step 50, the timer ( $T$ ) resets in step 58, and the work-out commences. The villain's speed is reset to the speed of the source in step 59. The heart rate is continually monitored during the work-out in step 60. If the heart rate falls below the  
20 minimum aerobic rate  $P_{min}$ , the villain's speed increases in relation to the source by the  $K$  factor in step 64. A message on the screen then advises the exerciser to increase his level of activity. Conversely, should it be detected in step 62 that the heart rate exceeds the optimal  
25 aerobic rate  $P_{max}$ , the speed of the villain decreases in relation to that of the source in step 66 (in a manner similar to that described above in step 56) and a message

cautions the exerciser to slow down. If however, exercise is occurring within the optimal range, then the speed of the villain equals the speed of the source in step 67. The time remaining in the work-out is recalculated and  
5 refreshed on the display in step 68 and a check is made in step 70 on whether the total time  $T_t$  elapsed in the main work-out period has reached the time  $T_z$  which has been preset. If not the program returns to step 60. Once the main work-out ceases as detected in step 70, the timer (T)  
10 is reset in step 72, and the source gains a continual speed advantage versus the villain in step 74, prompting the exerciser to slow down.

The cool-down period continues for at least a quarter of  
15 the time of the work-out 76. If the heart rate at the end of this period still exceeds 50% of the maximal attainable heart rate 78, a message is displayed recommending the exerciser to continue the cool-down period. The cool-down period thus continues until the heart rate of the exerciser  
20 drops to below 50% of the maximal attainable heart rate.

Although a preferred embodiment of the invention has been shown and described, numerous variations and modifications will readily occur to those skilled in the art. For  
25 example, the villain in the video game may be programmed to go faster, rather than slower relative to the player or source when the heart rate exceeds the maximum aerobic

level. The exerciser in this circumstance will get immediate feedback that exceeding the maximum aerobic limit will not place him in any greater advantage relative to the villain (and will actually be placed in a disadvantage relative to the villain) when the with aerobic limit is exceeded. This is consistent with research on exercise indicating that exercise levels exceeding the maximum aerobic limit provide little additional aerobic benefit over exercise within the preferred aerobic range, and may actually pose some risks for persons not in excellent physical condition. The present invention is not limited to the specific embodiment disclosed and the scope of the invention is limited only by the appended claims.

**I CLAIM:**

1. A combination exercise device and game apparatus, comprising:

an exercise device for aerobic activity;

means for sensing the activity output level of said aerobic exercise device, and for outputting an activity level signal having a characteristic indicative of said activity level;

means for sensing the heart rate of a user of the exerciser device ;

a video game having at least one user operated control for controlling the actions of at least one player, regulating means for regulating the relative action of said one player and one of an opposition piece or obstacle, display means for displaying the one player and the one of said opposition piece or obstacle, said regulating means further including means for increasing the speed of both the one player and the one of the opposition piece or obstacle in response to and in proportion to the activity level, and the regulating means further including means for rendering the video game more difficult for the one player relative to the opposition piece or obstacle by increasing the speed of the opposition piece or obstacle in response to the heart rate of the user falling below a first predetermined level.

2. The apparatus according to claim 1, wherein the exercise device is a bicycle.

3. The apparatus according to claim 1, wherein the exercise device is a treadmill.

4. The apparatus according to claim 1, wherein the exercise device is a stair climbing device.

5. The apparatus according to claim 1 wherein said first predetermined level corresponds to a minimum aerobic activity level for the user.

6. The apparatus according to claim 1 wherein the display means comprises means for displaying the heart rate of the user.

7. The apparatus according to claim 1 wherein the display means comprises means for displaying the output level of the exercise device.

8. The apparatus according to claim 1, wherein the regulating means renders the video game less difficult to the one player in response to the activity level exceeding a second predetermined level, said second predetermined level being greater than said first predetermined level.

9. The apparatus according to claim 1, wherein the first predetermined level is selected according to the user's age.

10. The apparatus according to claim 8, wherein the first predetermined level corresponds to the minimum heart rate of the user in an optimum aerobic exercise range, and wherein the second predetermined level corresponds to the maximum heart rate of the user in an optimum aerobic exercise range.

11. A game apparatus useable with an exercise device, comprising:

means for sensing the activity output level of an aerobic exercise device, and for outputting an activity level signal having



a characteristic indicative of said activity level;

means for sensing the heart rate of a user of the aerobic exercise device;

a video game having at least one user operated control for controlling the actions of at least one player, regulating means for regulating the relative actions of one of said one player and an opposition piece or obstacle, display means for displaying the one player and the one of said opposition piece or obstacle, said regulating means further including means for increasing the speed of both the one player and the one of the opposition piece or obstacle in response to and in proportion to the activity level, the regulating means further including means for rendering the video game more difficult for the one player relative to the opposition piece or obstacle by increasing the speed of the opposition piece or obstacle in response to the heart rate of the user falling below a first predetermined level.

12. The apparatus according to claim 11, further including an exercise device.

13. The apparatus according to claim 12, wherein the exercise device is an exercise bicycle.

14. The apparatus according to claim 12, wherein the exercise device is a treadmill.

15. The apparatus according to claim 12, wherein the exercise device is a stair climbing device.

16. The apparatus according to claim 11, wherein said first predetermined level corresponds to the minimum aerobic activity

level for the user.

17. The apparatus according to claim 11, wherein the display means comprises means for displaying the heart rate of the user.

18. The apparatus to claim 11, wherein the display means comprises means for displaying the output level of the exercise device.

19. The apparatus according to claim 11, wherein the regulating means renders the video game less difficult to the one player in response to the activity level exceeding a second predetermined level, said second predetermined level being greater than said first predetermined level.

20. The apparatus according to claim 11, wherein the first predetermined level is selected according to the user's age.

21. The apparatus according to claim 19, wherein the first predetermined level corresponds to the minimum heart rate of the user in an optimum aerobic exercise range, and wherein the second predetermined level corresponds to the maximum heart rate of the user in an optimum aerobic exercise range.

22. An exercise motivation apparatus useable with an aerobic exercise device and a video game having at least one user operated control for controlling the actions of said one player and at least one player, and which controls the relative actions of one of an opposition piece or obstacle, and which displays the one player and the one of said opposition piece or obstacle, comprising:

means for sensing the activity output level of an aerobic exercise device, and for outputting an activity level signal having

a characteristic indicative of said activity level;

means for sensing the heart rate of a user of the aerobic exercise device; and

regulating means for increasing the speed of both the one player and the one of the opposition piece or obstacle in response to and in proportion to the activity level, the regulating means further including means for rendering the video game more difficult for the one player relative to the opposition piece or obstacle in response to the heart rate of the user falling below a first predetermined level.

23. The apparatus according to claim 22, further including an exercise device.

24. The apparatus according to claim 33, wherein the exercise device is an exercise bicycle.

25. The apparatus according to claim 23, wherein the exercise device is a treadmill.

26. The apparatus according to claim 23, wherein the exercise device is a stair climbing device.

27. The apparatus according to claim 22, wherein said first predetermined level corresponds to the minimum aerobic activity level for the user.

28. The apparatus according to claim 22, further including display means for displaying the heart rate of the user.

29. The apparatus according to claim 22, further including display means for displaying the output level of the exercise device.

30. The apparatus according to claim 23, wherein the regulating means renders the video game less difficult to the one player in response to the activity level exceeding a second predetermined level, said second predetermined level being greater than said first predetermined level.

31. The apparatus according to claim 22, wherein the first predetermined level is selected according to the user's age.

32. The apparatus according to claim 22, wherein the first predetermined level corresponds to the minimum heart rate of a user in an optimum aerobic exercise range, and wherein the second predetermined level corresponds to the maximum heart rate of a user in an optimum aerobic exercise range.

33. A combination exercise device and game apparatus, comprising:

an exercise device for aerobic activity;

means for sensing the activity output level of said aerobic exercise device, and for outputting an activity level signal having a characteristic indicative of said activity level;

means for sensing the heart rate of a user of the exercise device;

timing means for measuring the length of time that a user has been using the exercise device, to provide at least two

different exercise phases, including a first phase until a certain first time period is reached and a second phase after said first time period is reached;

a video game having at least one user operated control for controlling the actions of at least one player, regulating means for regulating the relative action of said one player and one of an opposition piece or obstacle, and display means for displaying the one player and the one of said opposition piece or obstacle;

said regulating means further including means for increasing the speed of both the one player and the one of the opposition piece or obstacle in response to and in proportion to the activity level;

said regulating means including means for rendering the game more difficult for the one player relative to the opposition piece or obstacle by increasing the speed of the opposition piece or obstacle in response to the heart rate of the user rising above a first predetermined level when the timing means indicates that the user is in the first phase; and

said regulating means including means for rendering the video game more difficult for the one player relative to the opposition piece or obstacle by increasing the speed of the opposition piece or obstacle in response to the heart rate of the user falling below the first predetermined level when the timing means indicates that the user is in the second phase.

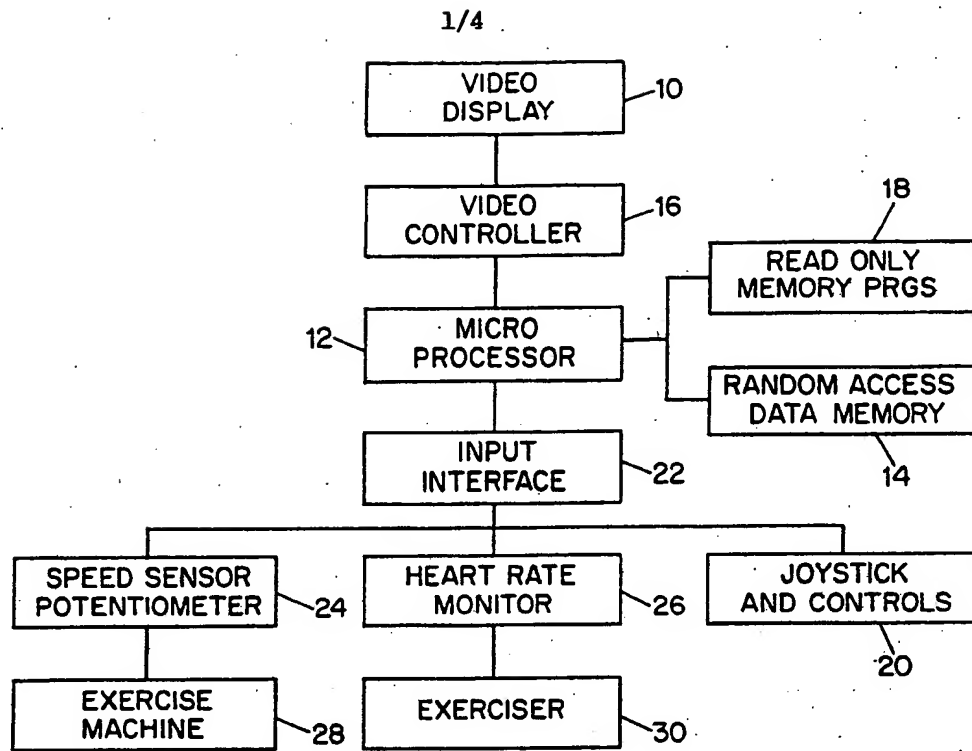


FIG. 1

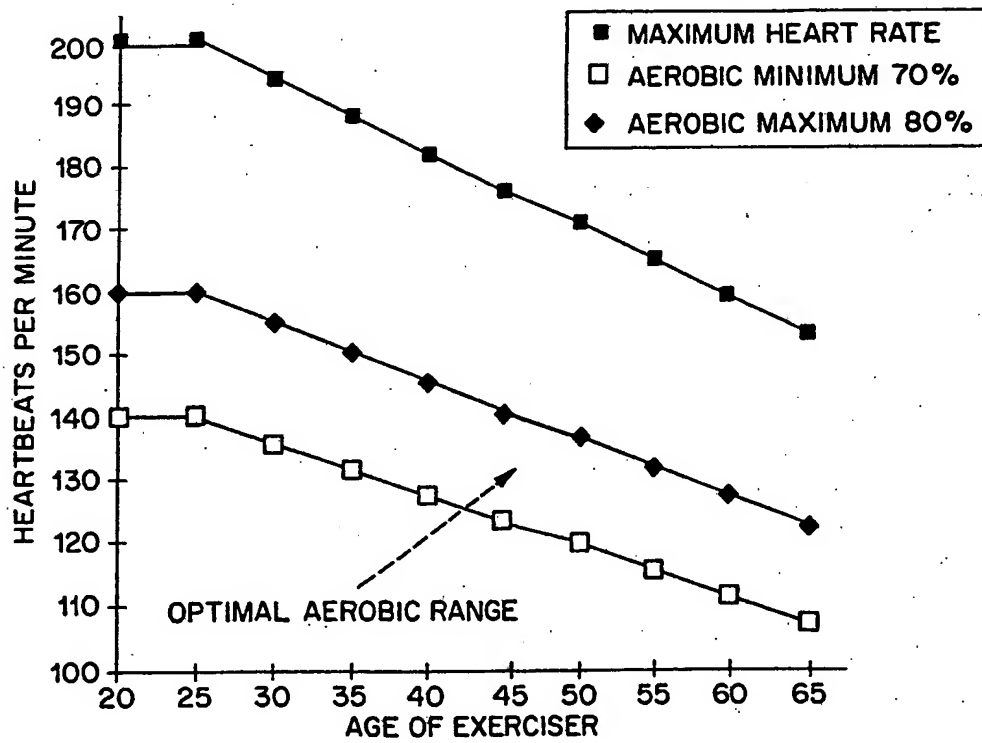


FIG. 2 (PRIOR ART)

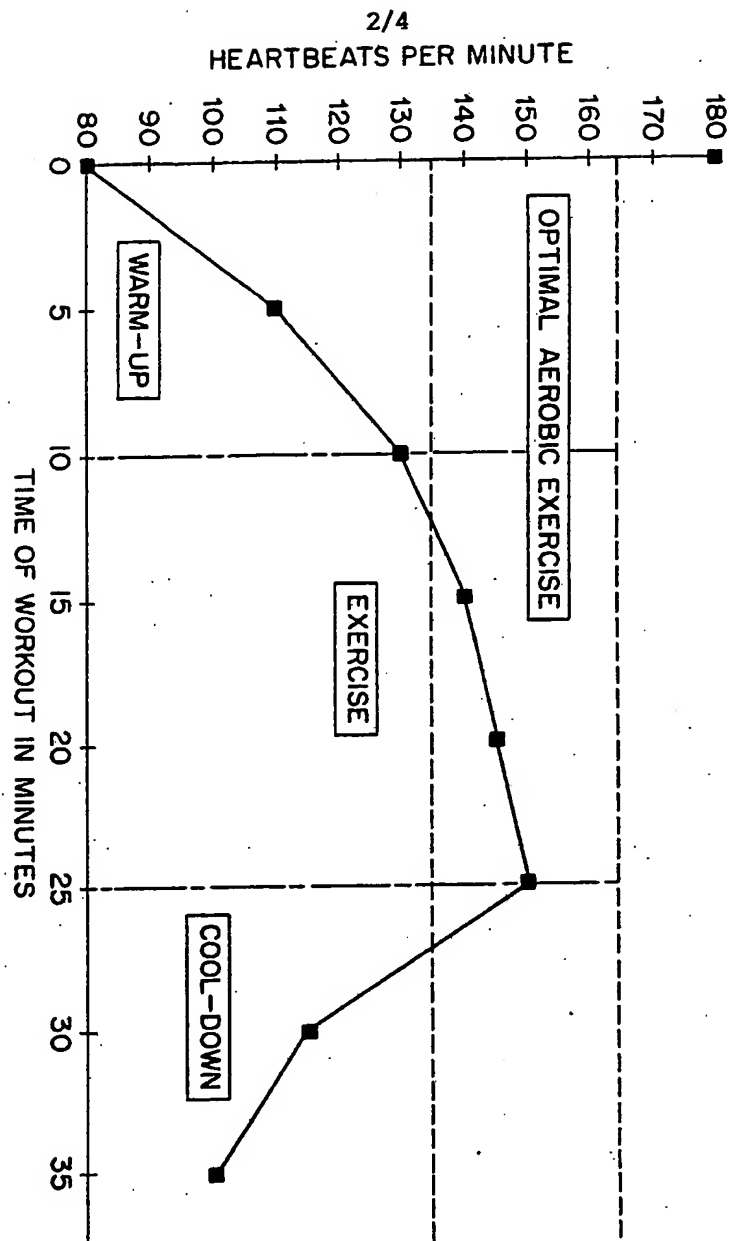


FIG. 3 (PRIOR ART)

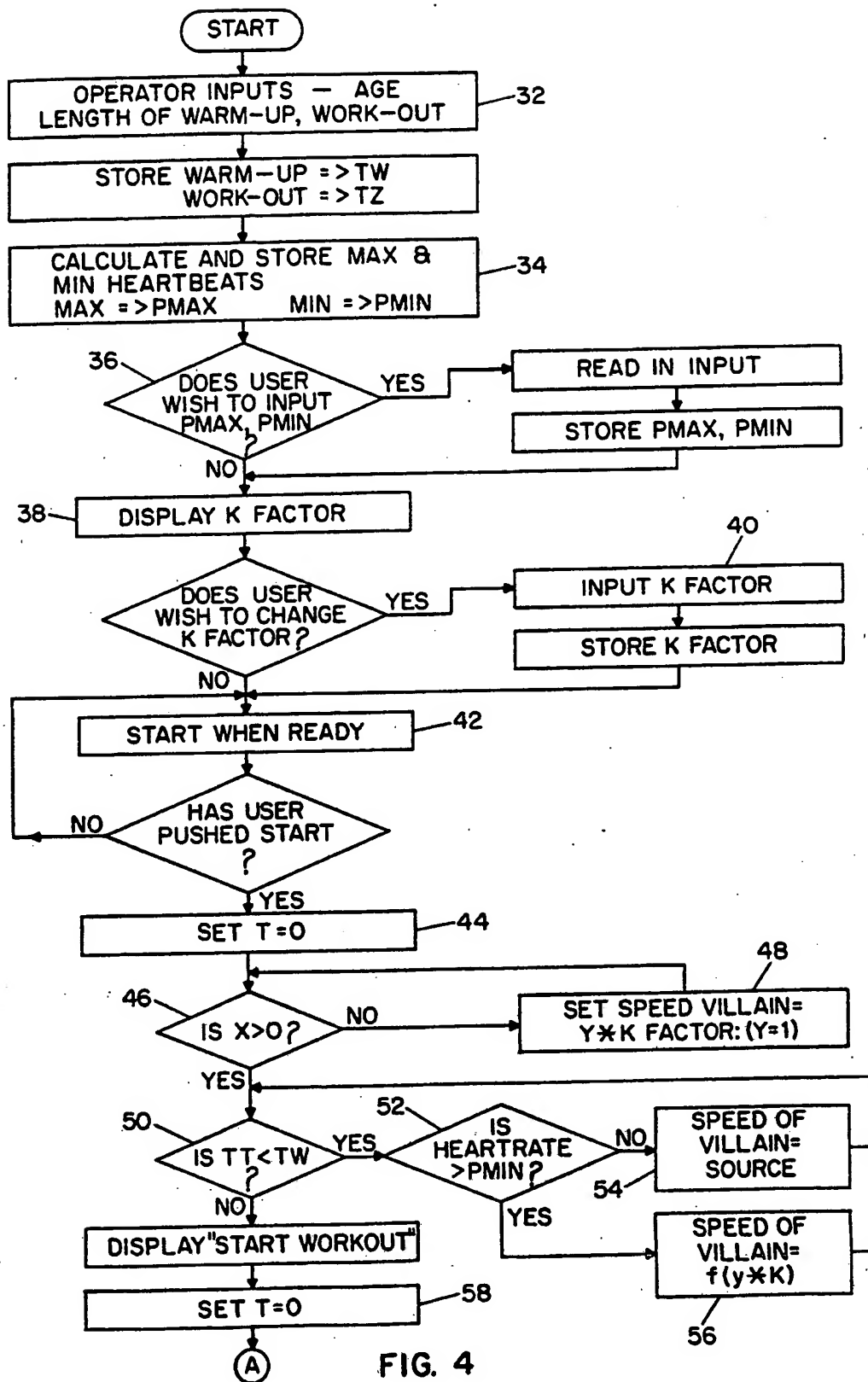


FIG. 4



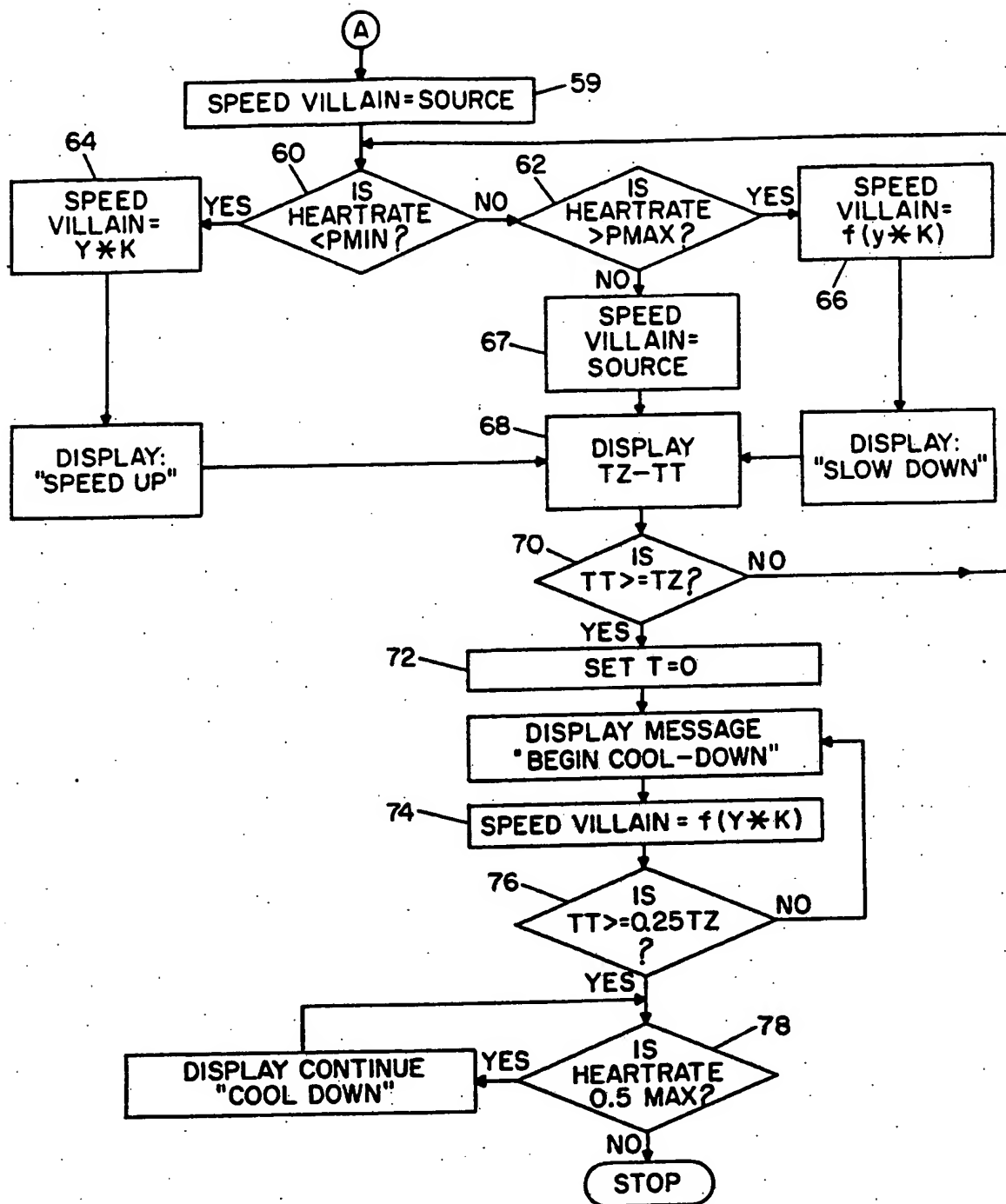


FIG. 4 (cont'd)

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/US90/07579

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC(5): G06F15/44; A61B 5/04; A63B 69/16; A63B 26/00		
U.S. CL. 364/413.04 272/73, DIG. 6; 128/707		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
U.S. CL.	364/410, 413.04; 128/689,696,707,905 272/73; 148B	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>9</sup>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	US, A, 4,358,118 (Flapp) 09 November 1982 (09.11.82)	
A	US, A, 4,751,642 (Silva et al.) 14 June 1988 (14.06.88)	
A	US, A, 4,643,421 (Meyer et al.) 17 February 1987 (17.02.87), see especially column 6, lines 42-66.	
A	US, A, 4,530,499 (Breslow et al.) 23 July 1985 (23.07.85), See especially column 5, lines 43-50.	
A	US, A, 4,149,716 (Scudder) 17 April 1979 (17.04.79)	
<p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other specific reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"A" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
22 March 1991		18 APR 1991
International Searching Authority		Signature of Authorized Officer
ISA/US		Clark A. Jablon/dal

## Continuation (Section III.)

International Application No. PCT/US90/07579

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4,278,095 (Lapeyre) 14 July 1981 (14.07.81).	
A	US, A, 4,408,613 (Relyea) 11 October 1983 (11.10.83)	
A	US, A, 4,512,566 (Bicocchi) 23 April 1985 (23.04.85).	
A	US, A, 4,512,567 (Phillips) 23 April 1985 (23.04.85).	
A	US, A, 4,542,897 (Melton et al.) 24 September 1985 (24.09.85).	
A	US, A, 4,630,817 (Buckley) 23 December 1985 (23.12.86).	
A	US, A, 4,637,605 (Ritchie) 20 January 1987 (20.01.07).	
A	US, A, 4,709,917 (Yang) 01 December 1987 (01.12.87).	
A	US, A, 4,720,789 (Hector et al.) 19 January 1988 (19.01.88).	
A	US, A, 4,735,410 (Nobuta) 05 April 1988 (05.04.88).	
A	US, A, 4,790,528 (Nakao et al) 13 December 1988 (13.12.88).	
A	US, A, 4,711,447 (Mansfield) 08 December 1987 (08.12.87).	
A	CA, A, 1,183,180 (Pannekoek) 26 February 1985 (26.02.85).	
A	Calmpute <sup>TM</sup> Calmprix Road Racing Game, Thought Technology Ltd., Montreal, Quebec, 1985.	
A	HR 100T heart rate monitor, Thought Technology, Montreal, Quebec, March 1983 product catalog.	
A	HR/BVP 100T <sup>TM</sup> heart rate monitor, Thought Technology, Montreal, Quebec, January 1985 product catalog.	
A	InfoWorld, July 9, 1984. S. Mace, Games Exhibit innovations (Consumers get a look at new construction sets, simulation software), pages 35,37.	